

The Balkan Capercaillie *Tetrao urogallus rudolfi* Dombrowski, 1912 (Galliformes: Phasianidae): Distribution History and Current Status in Bulgaria

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Abstract: Detecting trends in the distribution and abundance of metapopulations is crucial to determining their status and to employ timely and effective measures for their protection. The ongoing increase of anthropogenic pressure requires obtaining precise data on the trends of the threatened Balkan capercaillie in Bulgaria. Therefore, we updated the species distribution data on a 10×10 km UTM grid and compared them with the results of a study of the distribution and abundance of the species we conducted in 2008–2015. Through field studies across the country, we identified 4,866 species locations. The literature data on former distribution covered 116 UTM squares. During the field study, capercaillies were located in 77 squares of the 10×10 km (159 squares of the 5×5 km) UTM grid, seven of which unknown so far. After 1890, the species has gone extinct from a total of 46 squares (39.7%). The isolated population in the Western Balkan Mts. has gone extinct; only sporadic observations of single, presumably non-breeding, individuals were made. The current population for Bulgaria is estimated at 709–1,185 displaying males. The mean number of displaying males, when using the maximum value for the population size, is 8.4 males per 5 km square (n = 141 squares) and 3.98 males per lek (n = 298 leks).

Key words: Capercaillie, species distribution, species number, extinction, isolated population, review, field survey

Introduction

The Western capercaillie *Tetrao urogallus* (L., 1758) is a polygynous grouse species which at present inhabits high altitude and open boreal forests of Eurasia. The taxon comprises 12 subspecies (DE JUANA 1994, DURIEZ et al. 2007a) and two (southern and boreal) genetic lineages (DURIEZ et al. 2007a, RODRÍGUEZ-MUÑOZ et al. 2007, SEGELBACHER & PIERTNEY 2007, SEGELBACHER et al. 2003, LIUKKONEN-ANTTILA et al. 2004, BAJC et al. 2011, KLINGA et al. 2015).

In Bulgaria, the subspecies *T. u. rudolfi* Dombrowski, 1912 was identified based on genetic material from the Western Rhodopes and Pirin Mountains (DURIEZ et al. 2007b). Its extant, isolated metapopulation found in Bulgaria and northern Greece includes local populations in the moun-

tains of the Rila-Rhodopes Massif, including the Western Rhodopes, Rila, Pirin and Slavyanka Mts. The Bulgarian population is composed predominantly of southern lineage individuals, similar to the Cantabrian and Pyrenean populations (DURIEZ et al. 2007a, BAJC et al. 2011). The population is unique and distinct in the region, exhibiting characteristics of a long-term stationary population and should be considered as a glacial relict and probably a distinct subspecies (*T. u. rudolfi*) (BAJC et al. 2011).

The geographic isolation, the evolutionary significance and the relatively low number of individuals in the metapopulation require urgent conservation actions. Detecting trends in the distribution

and abundance of the isolated populations is crucial to determine their condition and adopt timely and effective measures for their protection. The local distribution of the capercaillie is amongst the most studied aspects of the biology of the species in Bulgaria and therefore, its range has been sufficiently studied over the years. Information about the distribution of the species in Bulgaria is available in a number of publications, including works such as HRISTOVICH (1890), PATEFF (1950), PETROV (1972, 1973), BOEV (1985), SIMEONOV et al. (1990), NINOV et al. (1994), BOEV et al. (2007), PETROV (2008) and BOEV & NIKOLOV (2015). Most of the available publications present the distribution of the species descriptively, based on mountain ranges and sites. This hinders data analysis and tracking of the dynamics of the distribution of the species over the years. BOEV et al. (2007) compiled the first summary of the published distribution information of the capercaillie in Bulgaria, based on the 10×10 km UTM grid. BOEV & NIKOLOV (2015) updated this information with existing data up to 2011. However, the ongoing increase of the anthropogenic pressure requires more precise data on the distribution and abundance of the capercaillie, which would help to effectively analyse and model the population trend and thus, aid in taking the appropriate management decisions. In the last ten years, there is no updated information on the species' distribution that is based on a population survey conducted with a species-specific method.

Data on the capercaillies's population size in Bulgaria were provided in publications such as PETROV (1972, 1973), BOEV (1985), BOEV (1981), SIMEONOV et al. (1990), KOSTADINOVA (1997), NANKINOV et al. (2004), KOSTADINOVA & GRAMATIKOV (2007), BOEV et al. (2007), PETROV (2008) and BOEV & NIKOLOV (2015). In multiple regional studies data were provided for local populations in mountainous regions and sites (counting of displaying males in National parks or Hunting and Forestry stations). Thus, current estimates on the population size in Bulgaria are expert assessments, which were not based on a complete population study across the country and were not carried through a species-specific method.

The aims of the present study were (1) to collect distributional and population data on the Balkan capercaillie through a publication review and field surveys based on species-specific method throughout its known and potential habitats in Bulgaria; (2) to compare our distribution and abundance data to historical records; (3) to establish recent trends on its distribution and population size.

Materials and Methods

Our study is based on information about the distribution and abundance of the capercaillie in Bulgaria for the periods from 1890 to 2015 and from the Quaternary. The Quaternary records are dated from the Early Pleistocene (Vaalian – Menapian / Biharian, approximately 1.2–1.0 Mya B.P.) to the Late Medieval Ages (i.e. Ottoman Period, 16th–18th c. A.D.). The recent distribution and abundance of the species is presented for two periods: from 1890 to 2007 and from 2008 to 2015. To establish the Quaternary distribution and the 1890–2007 distribution and abundance of the species we used published literature, museum collections and unpublished personal observations. The distribution and abundance of the species in the period 2008–2015 are based on data from the species-specific field study.

Study area

Field research took place in the mountains of Southern Bulgaria (Western Rhodopes), South-western Bulgaria (Rila, Pirin and Slavyanka) and Western Bulgaria (Western Balkan Mts.; Fig. 1). We checked the last known locations of the species in Central Balkan Mts., Sredna Gora Mts. (Central Bulgaria) (BOEV 1985) and Vitosha Mt. (Western Bulgaria) (NINOV et al. 1994). The study area falls between 1200 to 2300 m a.s.l. The climate is a mountainous variant of the transitional (Rila and Western Rhodopes Mts.), continental - Mediterranean (Pirin and Slavyanka Mts.) and temperate continental (Western Balkan Mts.). The mean July temperature varies from 14 to 18°C and that of January – from -2 to -7°C. Annual precipitation is 700–900 mm. The ground is usually covered by snow from mid-November to late April or May (depending on the elevation and aspect) (KOPRALEV 2002). Habitats are mainly old pine communities with the predominant participation of: Scots pine (*Pinus sylvestris* L.) or Norway spruce (*Picea abies* (L.) Karsten) in the Western Rhodopes; Scots pine, Macedonian pine (*Pinus peuce* Griseb.) and Norway spruce in Rila Mts.; Macedonian pine, Scots pine, Bosnian pine (*Pinus heldreichii* Christ) and dwarf mountain pine (*Pinus mugo* Turra) in the Pirin Mts.; Bosnian pine in the Slavyanka Mt.; and Norway spruce and European beech (*Fagus sylvatica* L.) in the Western Balkan Mts.

Literature data and personal communications

To present the distribution of the capercaillie in Bulgaria during 1890–2007, we compiled data from publications: scientific and popular articles, reports of studies, museum collections as well as from pre-

viously unpublished personal communications to the authors (only for the Western Balkan and Belasitsa Mts.). We reviewed pertinent publications from the period 1890–2015.

Field surveys

The study of the distribution and abundance of the capercaillie is difficult because of the secretive life of the species throughout most of the year and due to the rugged and forested landscapes inhabited by the species. Thus, establishing the distribution, locating leks and counts of individual birds were carried out by direct observation of individuals and by identified signs of their activity.

The field study of the distribution and the census of leks were carried out from 2008 to 2015 during the period of lekking activity - between 15th March and 31th May. We sampled known leks and searched for new ones. The field study was conducted with the participation of more than 30 field experts, who carried out over 800 field man-days. The study was based on the method for research and monitoring of the species of NIKOLOV (2008).

We visited territories that meet the habitat requirements of the species: open, unmixed and mixed coniferous communities with European blueberry (*Vaccinium myrtillus* L.) and lingonberry (*V. vitis-idaea* L.) from 1000–1200 m a.s.l. to the mountain pine zone. The species prefers middle-aged to old Scots pine forests with Norway spruce and European silver fir (*Abies alba* Mill.) (BOTEV et al. 1998), but also with black pine (*Pinus nigra* Arnold), Macedonian pine, Norway spruce and Bosnian pine. Less commonly it is found in mixed deciduous-coniferous communities and, as an exception, in deciduous communities predominantly of beech (SIMEONOV et al. 1990, BOEV et al. 2007). The leks are situated predominantly in sparse forests at the mountain ridges (less frequently on slopes), near clearings and small forest meadows (BOTEV et al. 1998).

Establishing the distribution and the confirmation of active leks was based on the following indicators: (1) Visual observation or audible identification of one or more male birds; (2) Visual observation of flocking or copulation of male and female birds; (3) Presence of activity trees – identified trees used for resting / roosting and/or for feeding (SANIGA 2003); (4) Finding additional features such as footprints of male and female birds, presence of traces of dragged wings, feathers or nests (SANIGA 2003).

The exact geographical position (x, y) of each locality (e.g. birds, active trees, leks and signs of activity) was marked using handheld GPS device with an accuracy of 5 m.

Counting of capercaillies

The numbers of the capercaillie were identified in the leks, where birds congregate during the reproductive season. Considering the broad extent of the study areas, to achieve the most effective counting of the number of birds, we combined two approaches. In the first approach, the number was obtained through direct observation (visual or auditory) of individuals. In the second approach, the number of males was determined based on the number of activity trees. The number of activity trees positively correlates with the number of present birds and the time of their stay (SANIGA 2003). Intestinal faeces (excreted regularly every 12–13 min, KLAUS et al. 1986) and cecal droppings (excreted once or twice a day, MOSS & HANSSSEN 1980) accumulate beneath the capercaillie feeding trees (identified by droppings and spilled needles) and roosting trees (droppings only), especially during winter. To ensure that a bird has stayed at one spot for some time, only heaps with three or more droppings were included (SANIGA 2003). To calibrate the accuracy we also conducted absolute counts of individuals in randomly selected leks identified to be active.

Compilation and analysis of data

The collected information about the distribution and abundance of species was integrated into a GIS database. We used a digital topographical map (BGMountains ver. 20161228) with names of localities and a 10×10 km UTM (MGRS) grid in the software MapSource, v. 6.15.11 (Garmin, Olathe, USA) to georeference published localities of the species.

For comparison and identification of trends in distribution, the locations of identified individuals and their activity in the field (n = 4,866 locations) were intersected with pre-generated UTM grids (10×10 km and 5×5 km) with ArcGIS 10 software (ESRI 2014). Using a 10×10 km UTM grid we compared the 1890–2008 and 2008–2015 (based on the field study) distribution of the capercaillie in Bulgaria and identified trends of range expansion/contraction. The 5×5 km UTM grid was used to provide more precise data on the current distribution, based on the field study.

The altitudinal range is represented by the frequency histogram and descriptive statistics of the established locations of specimens and traces of their activity using software STATISTICA 7.0 (STATSOFT INC. 2004). The altitudes of the identified locations were extracted automatically based on a 20-m digital elevation model using ArcGIS 10.

The number of individuals is represented based on the direct observations of displaying males (mini-

imum number) and to the count of activity trees (maximum), relative to 1) the 5×5 km UTM grid and 2) to the identified leks. We calculated the percent of leks, based on the number of displaying males in them and compared these with older data provided by Petrov (1973). The size of the leks was determined by creating a polygon by generating buffers of 300 m around the locations of identified activity trees and signs of activity. This buffer size was chosen based on field calibration and the results of a telemetry study (PLACHIYSKI et al. 2016).

Results

10×10 km UTM grid distribution

As a result of the field survey and literature review, for the period 1890–2015 the capercaillie has been located in 123 squares (9.79%) out of the 1,257 squares of the 10×10 km UTM grid of Bulgaria (Fig. 1; Table 1; Appendix 1). During the field study (2008–2015), the species was located in 77 squares: 7 have not been reported in publications; it was confirmed in the other 70 squares. Since 1890, the species has disappeared from a total of 46 squares (39.7%; Table 1); it is no longer present in the Central Balkan, Sredna Gora and Vitosha Mts.

5×5 km UTM grid distribution

Through the field study, we identified localities of the capercaillie within 159 squares of the 5×5 km UTM grid (Fig. 2): 99 squares in the Western Rhodopes, 37 squares in Rila, 18 in Pirin, 3 in Slavyanka and 2 in Western Balkan Mts.

Altitudinal distribution

The average altitude of the established locations (n = 4,866) of the species is 1801 m a.s.l. (SE ± 2.54).

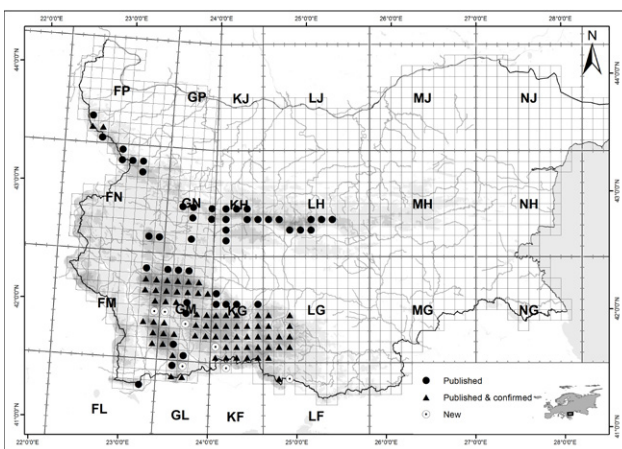
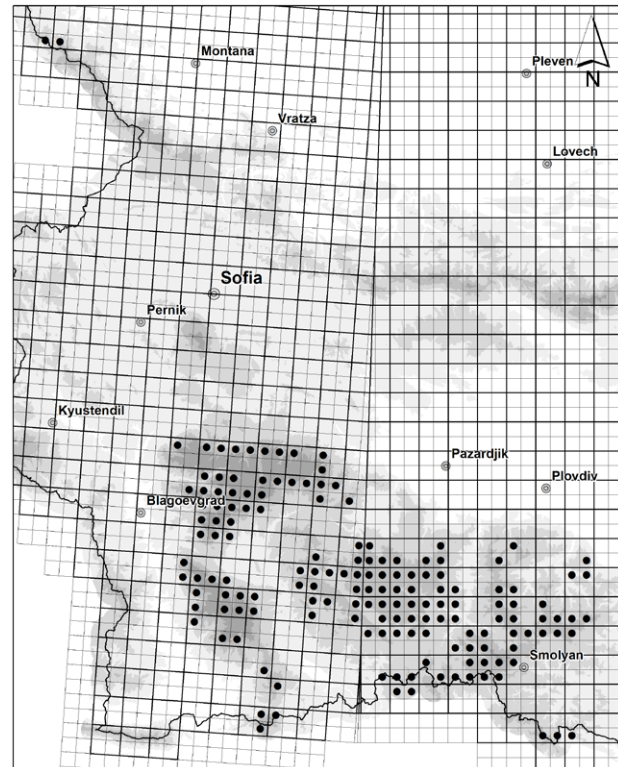


Fig. 1. Distribution of the capercaillie in Bulgaria for the period 1890–2015, based on a 10×10 km UTM grid.

The minimum altitude at which the species was established was 1016 m a.s.l. and the maximum was 2247 m a.s.l.. The majority (98.7%) of the species presence observations were recorded between 1400 and 2200 m a.s.l. (Fig. 3).

Number of capercaillie

The estimated number of displaying males counted in leks (n = 298 leks) was from 709 to 1,185 ind. (Table 2).



Legend

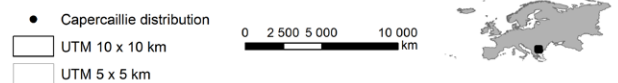


Fig. 2. Distribution of the capercaillie in Bulgaria (only the western part shown here) in 2008–2015, based on the 5×5 km UTM grid.

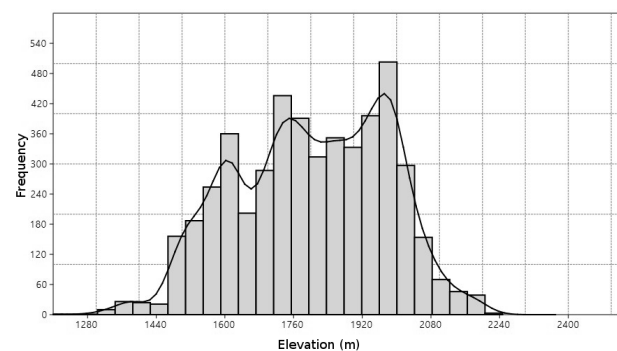


Fig. 3. Frequency distribution of the elevations of the identified locations of the capercaillie in Bulgaria in 2008–2015.

Table 1. Distribution of the capercaillie (per mountain regions) in 1890–2015, based on 10×10 km UTM grid. TNS – Total number of squares, based on literature review and field observations; ULS – squares with localities based on literature review, but not confirmed by the field study; CDS – squares denoting the current distribution of the species; CLS – squares with localities based on literature review and confirmed by the field study; NLS – squares with new localities obtained through the field study.

Territory (Mountain)	TNS	ULS	CDS	CLS	NLS
Western Rhodopes	53	7	46	42	4
Rila	21	4	17	15	2
Pirin	13	3	10	9	1
Slavyanka	2	0	2	2	0
Western Balkan	9	7	2	2	0
Central Balkan	19	19	0	0	0
Sredna Gora	3	3	0	0	0
Vitosha	2	2	0	0	0
Belasitsa	1	1	0	0	0
Overall	123	46	77	70	7

Table 2. The number of displaying males and leks (per mountain regions) estimated within the scope of conducted field survey (2008–2015).

№	Territory (Mountain)	Leks	Minimum	Maximum
1	Western Rhodopes	188	454	757
2	Rila	79	184	307
3	Pirin	25	46	84
4	Slavyanka	5	24	35
5	Western Balkan	1	1	2

We registered displaying males at 298 leks, which fall within 141 UTM 5×5 UTM squares (Fig. 4). Therefore, the average number of displaying males, using the estimates for the maximum number, was 8.4 ind. (CI±95%=7.34 – 9.46; SE=0.54) per square inhabited by the species (n=141) and 3.98 ind. (CI±95%=3.69 – 4.26; SE=0.14) per lek (n=298).

Discussion

Past distribution

Evolutionarily, the subfamily Tetraoninae is one of the relatively young families that appeared during the Late Pliocene (JÁNOSSY 1991). In Bulgaria tetraonides were identified not only in the Pleistocene but also in the Pliocene deposits (Muselievo and Dorkovo). This suggests, that even in the second half of the Pliocene the subfamily Tetraonidae featured prominently in the paleo-ornithocenosis in South-east Europe, while it penetrated later in Central and especially in Western Europe, where it became more widespread only during the Pliocene (BOEV 1999).

Quaternary localities of the capercaillie in Bulgaria were linked to 16 squares (Fig. 6; Appendix

1, Table 2): three from the Pleistocene (1.2 Mya–12000 B.P.) and 13 from the Holocene age (ca. 218 < 12000 B.P.).

The results of recent genetic studies on the differentiation of the capercaillie in the Balkans (BAJC et al. 2011, KLINGA et al. 2015) and the data on the Quaternary distribution of the species (VASILEV 1985, IVANOV & VASILEV 1975, 1979, BOEV 1999, 2001, 2001a, 2001b, 2002, 2006, 2016, SPASSOV et al. 2001, MITEV 2004, 2006, 2016) show that historically the range of the southern lineage subspecies was significantly wider compared to the present one. These data correspond with the statement of BOEV & NIKOLOV (2015) that in the past the species inhabited the mountains as well as the forested pre-mountain foothills. The subspecies reached the Dinarids to the west (BAJC et al. 2011) and at least until the Southern Carpathians (Făgăraş Mtns.) to the north (KLINGA et al. 2015).

Current status

10×10 km UTM grid distribution

At the end of the 19th c., the distribution of the capercaillie in Bulgaria comprised the higher mountains,

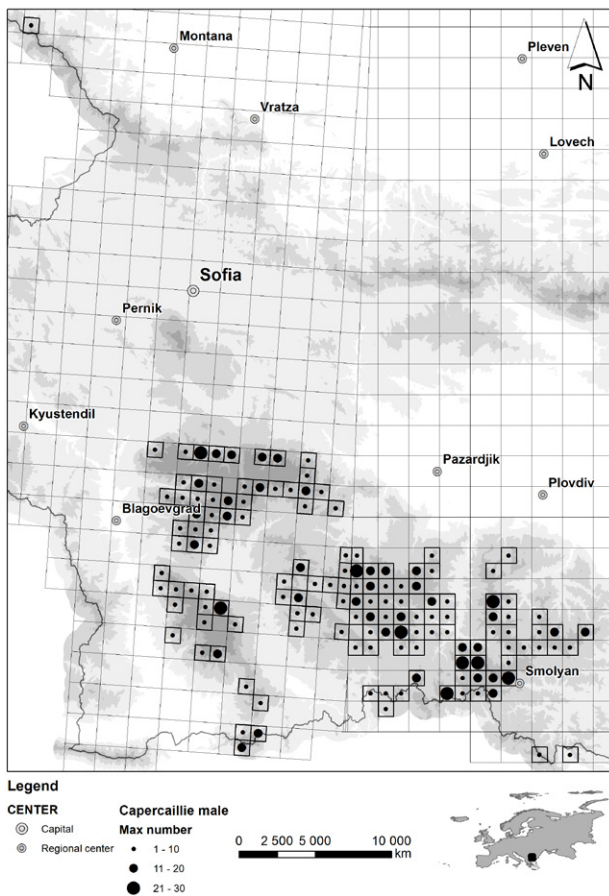


Fig. 4. Number of displaying males, based on 5×5 km UTM grid, using the maximum values of this parameter, identified during the field study conducted in 2008–2015.

including the Western and Central Balkan (east to the Shipchenska Mt.), Sredna Gora, Rila, Western Rhodopes, Pirin and Vitosha Mts.. The decrease of the species distribution and its concentration in the higher mountainous areas is due to increasing of anthropogenic pressures and the resulting destruction, degradation and fragmentation of the species habitats; illegal hunting and disturbance of the species (BOEV et al. 1980, BOEV 1985, BOEV et al. 2007). The trend of shrinking of the species' range in the country has continued from the beginning of 20th c. until present days, with local populations of species preserved in the Western Rhodopes, Rila, Pirin and Slavyanka Mts.

The comparative review of the current distribution of the species in the Atlas of the breeding birds in Bulgaria (BOEV et al. 2007) and the results of our field study showed that in 48 squares the occurrence of the species was confirmed, in ten – not confirmed and in 29 squares we found localities not presented in the Atlas.

Central Balkan

Known data indicate that the process of shrinking of the distribution of the species in the Central Balkan

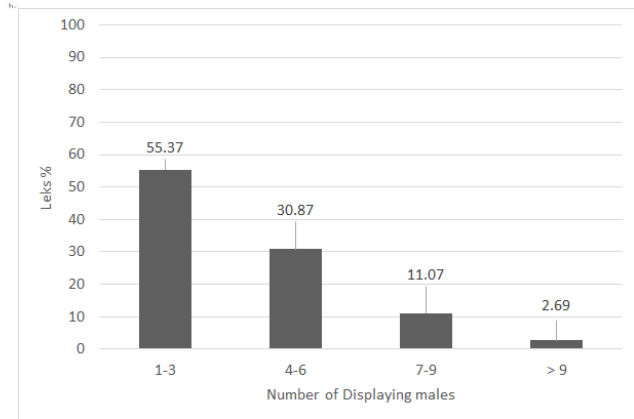


Fig. 5. Breakdown of number of displaying males per lek (n=298), based on the maximum estimates of individual counts.

started at the beginning of 20th c. Localities in the eastern parts existed until 1920 in the area of Uzana (BOEV 1985) and until 1930 in the area of Shipka Peak (PETROV 1973). Localities in the rest of the mountain gradually disappeared, with the latest observation of the species being in 1981, near the Tsarichina Nature Reserve (BOEV 1985). Our field data confirmed the disappearance of the species from the last known localities in the Central Balkan Mts..

Western Balkan

Analogous to the central part, in the Western Balkan the reduction in the capercaillie localities began in the onset of the 20th c. By 1925 the individuals in the vicinity of the Murgash Peak disappeared or were on the brink of extinction (PETROV 1973). By 1994, the capercaillie disappeared in the region spanning from the Todorini Kukli to Kom Peaks (NINOV et al. 1994). By 2002 in Western Balkan were registered 29 individuals and in 2003 – 17, with no further observations after that (PETROV 2008). Still, in the vicinity of the Chuprene Nature Reserve, we obtained data for observations of single individuals in 2011–2014. The field studies carried out in 2013–2015 located signs of activity of single individuals. Our results support the conclusion of PETROV (2008) that the population has disappeared from the region, with only single individuals present, which are the remains of the local population.

Sredna Gora

The distribution of the capercaillie in Sredna Gora in the 20th c. is likely due to the dispersion of individuals from the Balkan Mts. (PETROV 1973). The reduction of the distribution of the species in the Balkan Mts. limits the dispersal of individuals to Sredna Gora and leads to the geographic isolation of the extant local population. As a result of the anthropo-

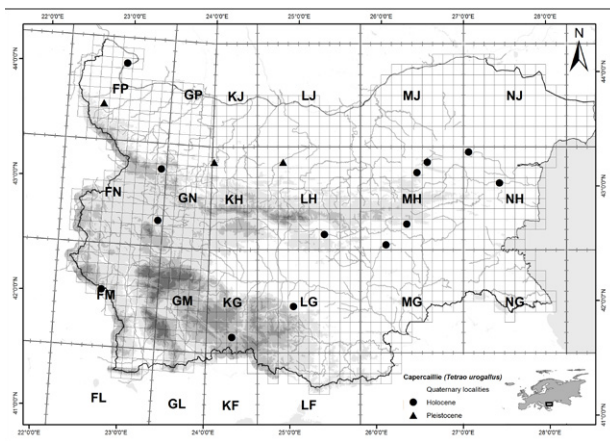


Fig. 6. Quaternary localities of capercaillie in Bulgaria. Circle – Holocene localities; Triangle – Pleistocene localities.

genic pressure, around 1928 the species disappeared from the vicinity of the Bratiya Peak (PETROV 1981) and around 1949 disappeared from the locality between Ognyanovo and Golema Rakovitsa Villages (BOEV 1985).

The data showed that the local population of the capercaillie in the Central and Western Balkan and Sredna Gora Mts. disappeared in about 100 years. Possible reason for this could be an increase of the anthropogenic pressure, manifested in the destruction and fragmentation of habitats, disturbance and excessive hunting. As a result of the fragmentation of the habitats, the negative impact of predation also has increased.

Vitosha

A local population existed up to 1920 (PETROV 1973, BOEV 1985). A repopulation at the coniferous forest habitats began around 1953, likely as a result of dispersal of birds from Rila Mts. (BOEV 1985). Around the beginning of the 1990s (NINOV et al. 1994) and around the beginning of the 21st c. single individuals occurred in the mountain. Our field work during 2013–2014 failed to detect the species, confirming the conclusion of PETROV (2008) that the species is likely locally extinct.

Rila

The major part of the species localities were situated around the treeline on the territory of the Rila National Park (hereafter NP). During our field studies (2010–2014) we could not confirm the presence of the species in four squares, where the species had gone extinct since the beginning of the 20th c. Some of them, such as those situated between the Dospey and Govedartsi Villages, in the vicinity of Borovets and Sitnyakovo, probably maintained isolated pop-

ulations until the middle of the 20th c. Populations in the north-western Rila, above Ovchartsitsi Village (NINOV et al. 1994), likely disappeared by the end of the century. These former locations were at lower elevations, completely within the extreme northern part of the mountain, outside of the Rila NP. These areas are the most urbanized, with large-size resorts and well-developed sport and tourist infrastructure and transport network.

Western Rhodopes

During our field study (2008–2015) we confirmed most of the known localities for the species on the 10×10 km UTM grid. Here are concentrated 59.7% of all 10×10 km squares in which the capercaillie is found, which defines the key role of the territory for its conservation. We could not confirm localities in seven 10×10 km squares. In five squares located at lower elevations, in the extreme northern parts of the mountain, we identified disappearance of localities. The reduction of these northern localities is comparable with that in the Rila Mts. They were situated closer to denser urbanisation compared to the rest of the mountain, in territories with developed tourist and road infrastructure and intensive forestry. The disappearance of the localities can be dated from the middle of the 20th c. to the beginning of the 21st c. The other two squares, where the species' presence was not confirmed, are located in the lower, extreme north-western part of the Western Rhodopes. As these areas are crucial for the exchange of individuals between localities in the Rhodopes and Rila Mts., this signals a tendency for the two region's spatial separation and isolation. It is necessary to conduct additional studies on the distribution of the species in these areas in order to explore their importance. It is essential to continue field studies in locations where the species has not been found within the framework of this study, but which maintain suitable habitats. Such 10×10 km squares are KF99, LF08 and LF09 in the south-eastern part of the Western Rhodopes and GM35 and GM45 in the north-western part.

Pirin

During the field studies (2012–2014) the distribution of the capercaillie was confirmed in most of the known localities, at the 10×10 km grid level. The main part of the localities of the species were located around the treeline, within the Pirin NP. The species has not been confirmed in three squares. Two of these are located in southern Pirin, outside the Pirin NP. In this area, the optimal habitats for species distribution are located at the border between three squares: GL19 and GM20, in which its presence was not es-

tablished, and GL29, where we identified a new locality. In this respect, it is very likely that the locality will move or reduce in size so that it falls within a single square (GL29). The territory of southern Pirin Mts. plays a key role in the exchange of individuals between localities in Pirin and Slavyanka Mts..

Slavyanka

We confirmed all known localities of the capercaillie at the level of the 10×10 km UTM grid. Most of them were located around the treeline on the territory of the Ali Botush Nature Reserve.

Belasitsa

The data on the species distribution in Belasitsa Mts. were limited to unpublished information about single observations. The presence of single individuals can be explained by dispersion of birds from the neighbouring Slavyanka Mts..

5×5 km UTM grid distribution

The results of the study suggest the rapid disappearance of the population of the Balkan Mts. and a clear trend for reduction in the distribution and abundance of the Rila-Rhodopes population. To adequately follow up these trends in the future, an optimization of the process of data collection and improvement of the quality of information on the distribution and population size of the species are required. In this respect, the analysis of the distribution and abundance of the capercaillie based on the 5×5 km UTM could provide more precise detection of trends in these population characteristics. In the future, this foundation should be further developed through continued sampling in squares with suitable habitats in which the species' presence has not been confirmed. The available results support the expressed hypothesis of an increasing spatial isolation between localities in Rila and Rhodopes; studies in this direction should continue.

Cross-border localities

During the field studies in 2008–2015, several cross-border localities of the capercaillie were identified directly on the mountains ridges along the border between Bulgaria and Greece. In the Western Rhodopes, we registered such localities falling within seven squares of the 10×10 km (14 squares of the 5×5 km) UTM grid. For the territory of the Slavyanka Mt. we established two squares of the 10×10 km (three squares of the 5×5 km) UTM grid. To obtain information that is optimal quantitatively and qualitatively, both to identify cross-border localities and to clarify the overall state of the capercaillie's metapopulation, it is necessary to conduct

a study similar to ours in the Greek parts of the two mountains.

Number of capercaillie

In 1933, the number of capercaillies in the Western Rhodopes was estimated at 4,500 birds, which decreased to 2,600 by 1964 (BOEV 1985). In 1972, the number of the entire national population was estimated at 2,606 individuals (PETROV 1972, 1973). In 1980–1984, the average number of the species was 1,900 ind. (range 1756–2068) (BOTEV 1981, SIMEONOV *et al.* 1990). In 2002–2006 the number was 2,597±238 ind. (Mean±StD; n = 5, range 2,190–2,798), with about 1,000 mature males (PETROV 2008). In 2008–2015 the number was estimated at 709–1,185 displaying males (this study). The comparative examination of the data shows a drastic reduction in the capercaillie numbers from the first half of the 20th c. to the early 1980s, most likely as a result of habitat loss, disturbance and excessive selective hunting of males (BOEV 1985, BOEV & NIKOLOV 2015). The data from 2002–2006 (PETROV 2008) and 2008–2015 (this study) show a relatively stable, albeit low number of the species in Bulgaria.

The percentages of birds per mountains, when comparing both number of displaying males and the total number of individuals, differed considerably for the different periods. Compared with the data in PETROV (2008) for the period 2002–2006, during the last decade the percentage of birds has decreased by about 15.34% in the Western Rhodopes, while it has increased by about 12.1% in the Rila Mts., and remained stable in the Pirin Mts.. This comparison is plausible, if we assume that the sex ratio has remained stable and if the number of the males has remained stable during the two periods (which we have confirmed).

The breakdown of number of displaying males per lek in 2008–2015 showed significant differences with the data of PETROV (1973). The leks with up to 5 displaying males increased by about 18% (from 62% to 80%), while those with 6–12 and over 12 displaying males decreased with about 7% (from 26% to 19%) and 11% (from 12% to 1%), respectively. Due to the lack of information on the number of leks in PETROV (1973) and the applied method to determine the size of the leks, we cannot state categorically the reasons for this difference.

Conclusions

During the Quaternary the capercaillie had a greatly extended range as compared to its current distribution, inhabiting both the higher mountainous parts as

well as the forested pre-mountain foothills. At the end of the 20th c., the distribution of the capercaillie comprised the higher mountains, including the Western and Central Balkan Mts. (east to the Shipchenska Mt.), Sredna Gora, Rila, Western Rhodopes, Pirin and Vitosha Mts. The decrease of the species' range and its concentration at the higher mountainous areas is due to increasing of anthropogenic pressures and the resulting destruction, degradation and fragmentation of the species habitats, illegal hunting and disturbance of the species.

The current distribution of the metapopulation of the capercaillie in Bulgaria covers territories predominantly between 1400–2200 m a.s.l. in the mountains Western Rhodopes, Rila, Pirin and Slavyanka. During the period 2008–2015 the species was located in 77 squares of the 10×10 km and 159 squares of the 5×5 km UTM grid. The range of the species is shrinking, because of its disappearance from extreme northern localities in the Rila and Western Rhodope Mts. In less than 100 years, the local populations of the species on the territory of the Balkan, Sredna Gora and Vitosha Mts. Have disappeared. Since 1890, the species has disappeared from a total of 46 (39.7%) squares of the 10×10 km UTM grid. The current number of individuals is stable but low with a trend towards a reduction in the Western Rhodopes and an increase in the Rila Mts. It is necessary to conduct further studies to establish the environmental factors determining the distribution and the abundance of the species.

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Supplementary Material

This article contains supplementary material (Appendix 1) available online at the site of the journal. It consists of two tables:

Table A1. Localities of capercaillie in Bulgaria in 1890–2015 based on literature review and unpublished data, with their 10x10 km UTM grid distribution.

Table A2. Quaternary localities of capercaillie in Bulgaria and their 10x10 km UTM grid distribution.

Acknowledgements: We acknowledge the support of colleagues who helped to study the distribution and number of capercaillie, in particular A. Stamenov, A. Dzhindzhieva, B. Borisov, D. Dobrev, G. Daskalova, G. Georgiev, G. Gerdzhikov, G. A. Stoyanov, G. P. Stoyanov, I. Elenchev, K. Andonov, K. Valchev, K. Uzunov, M. Hodzha, M. Iliev, N. Yonchev, P. Genov, P. Shurulinkov, R. Georgieva, R. Kolchagov, R. Mirchev, S. Gelov, S. Georgiev, S. Nikolov, V. Angelova, V. Chapkanski, V. Milushev, V. Mladenov, V. Peykov, V. Vasilev, Y. Ilchev, Z. Bakalov. The studies were supported by: Project № 5103020-39-682 “Action plans for capercaillie, three-toed woodpecker and white-backed woodpecker”, developed and implemented by the Bulgarian Biodiversity Foundation (BBF) and financed by the Operational Programme Environment 2007–2013; Project “Providing incentives of nature friendly forest management, develop business partnerships and sustainable hunting for efficient management of high conservation value forests and species in the Western Rhodope Mts. and Rila Mts.”, developed and implemented by the Conservation Society “Biosphere” and BBF and financed by GEF SGP & UNDP; Project “Sustainable management of the capercaillie population and its habitats in the Municipality of Devin and Western Rhodope Mts.: towards multifunctional forests use and sustainable hunting”, developed and implemented by BBF and financed by SDC additional funding mechanisms, Co-financing fund. We appreciate the constructive comments by Yurii Kornilev, Tseno Petrov and reviewers on an earlier draft of the paper.

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Received: 15.07.2016
Accepted: 21.09.2017

